Goals of the Environmental Restoration Program:

- ✔ *Fully comply with Federal, state and local requirements.*
- ✔ *Act immediately to eliminate human exposure to contamination and remove or contain contamination that poses imminent threats.*
- ✔ *On a national basis, first cleanup those sites that pose the greatest relative risk to human health and the environment.*
- ✔ *Develop partnerships with EPA, state and local regulatory agencies.*
- ✔ *Involve the local community in the Defense Environmental Restoration Program. Establish Restoration Advisory Boards (RABs). Encourage stakeholder participation by making information available in a timely manner, providing opportunities for public comment, and considering all comments in the decision-making process.*
- ✔ *Expedite the cleanup process and demonstrate a bias for action.*
- ✔ *Consider planned land use in developing cleanup strategies.*

Chapter 1

Department of the Navy Installation Restoration Plan

The Navy Mission

The United States has long been a maritime nation, dependent upon the seas for both commerce and defense. Maintaining a sustained forward presence, fully engaged, is vital if the United States is to protect and project American interests around the world. Our naval forces provide strategic deterrence, crisis response, and humanitarian operations in support of national security objectives and our nation's global interests. Tasked with defending the freedom of the seas, the Department of the Navy is also involved in protecting the Earth itself. From cleanup to compliance to resource conservation to pollution prevention, the Navy is working hard to provide a cleaner, safer world. In doing so it is working to ensure a better future.

The Navy Is Cleaning Up

To ensure the future of that safer world, the Navy must continue to effectively perform its missions. And effective performance includes providing working conditions which will protect human health and the environment. That entails cleaning up areas where past Navy operations have affected the environment.

The Navy's cleanup program identifies, studies, and cleans up past spill and hazardous waste disposal sites on Navy and Marine Corps installations within the United States and its territories. The Navy started the Installation Restoration Program in response to the Superfund legislation of 1980, even though that legislation did not specifically apply to federal facilities. In the early part of that decade, the Navy asked for information from each of its bases about the kinds of activities it conducted. The Navy carefully evaluated the information it collected, then recommended that 79 bases be studied further. The cleanup program was underway.

In 1986, Congress passed the Superfund Amendments and Reauthorization Act which brought all federal facilities under the umbrella of Superfund. It created the Environmental Restoration Program along with funding via the Defense Environmental Restoration Account to address past hazardous waste contamination cleanup. The passage of this law required the Navy to follow Environmental Protection Agency (EPA) rules and regulations and to have a program equivalent to the EPA's Superfund program.

In 1997, in an effort to promote flexibility and to improve performance, Congress divided the Defense Environmental Restoration Account among the individual services. The new Navy account is designated Environmental Restoration, Navy (ER,N). Funds appropriated by Congress and placed in this account pay for the Department of the Navy's Environmental Restoration Program. The program plan, which is updated annually, documents site cleanups and projects future cleanup goals.

Restoring The Future

The Navy is emphasizing innovative approaches to program management with an overall goal to reduce the risk to human health and environment, and to accomplish cleanups more quickly, especially at closing bases to speed up the return of land to local communities for reuse. Our SMART Cleanup strategy Saves Money and Accelerates Remediation in a Timely manner. It is the cornerstone of our strategic approach to a safe environment for future generations.

The Navy cleanup program is based on the cleanup requirements found in two federal laws: (1) the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and (2) the Resource Conservation and Recovery Act (RCRA). The same approach is followed at active installations and those falling under the Base Realignment and Closure Act.

Endangered Least Tern

Moving Ahead Full

The Department of the Navy, which executes the environmental restoration program through the Naval Facilities Engineering Command and it's eight Engineering Field Divisions/Activities, has the responsibility to clean up Navy and Marine Corps property, both active bases and those on the Base Realignment and Closure (BRAC) list. Since the environmental restoration program began, the Navy has identified more than 4,450 potentially contaminated sites at more than 200 bases. As of 30 September 1997, more than 1,250 of these sites were under study, over 315 had a cleanup underway, over 1,000 had no current action, and more than 1,850 were considered to be response complete. That means that installation restoration actions are considered completed by the Navy, that the site is not a threat to public health or the environment, and that the proper authorities have been or are being notified of this decision.

Fire fighting training area, a typical Navy restoration program site, at NAS Whiting Field

Of the 4,450-plus potentially contaminated sites, 3,450 are at active installations while nearly 1,000 are located at bases slated for closure or realignment. The Navy prioritizes cleanup work using a risk management approach. The Navy ranks its sites in terms of risk to human health and the environment. Those sites posing a greater relative risk are cleaned up first. Other factors that impact cleanup schedules include community concerns, mission impacts, and regulatory requirements. Funding priority is given to BRAC sites with approved reuse plans. This allows property to be transferred more quickly to promote reuse and create new jobs in the

local area. When property is transferred, the federal government provides assurances that all necessary cleanup actions have been or will be completed.

In 1997, over 2,300 active sites still required further study or cleanup. These sites have been prioritized by relative risk with 1,100 ranked high, over 600 ranked medium, and more than 600 ranked low in relative risk. The Department of Defense has set for the Navy a goal to finish its cleanup work by the year 2014. It has also set ambitious milestones with cleanup of all high relative risk sites to be done by 2007, medium relative risk sites by 2011, and low relative risk sites by 2014. All sites at closing bases must be completed by 2005.

Site of a former pesticide shop at NSGR Sabana Seca, Puerto Rico

How The Job Gets Done

The Navy is making substantial progress in its environmental restoration program despite challenges which are unique to the sea service. Many of these challenges are mission-related and involve operational factors. One such factor is the geographical location of most Navy and Marine Corps bases, in particular their proximity to coastal areas, which generally have environmentally sensitive habitats and large, surrounding community populations. Heavily industrialized operations in support of ships, aircraft and weapons are typical of most naval installations and present significant challenges. The impact of base closures and the need to convert sites to alternative uses further complicate cleanup issues. To get the job done, the Navy depends on partnerships with regulatory agencies and citizen advisory groups, and on the use of innovative and cost-effective technologies to carry out its cleanup efforts.

RAB meetings provide a forum for partnering with the public and regulatory agencies

Partnering:

In the Navy cleanup program, partnering is a process by which multiple individuals and organizations can perform as a team to achieve mutually beneficial goals. The Navy actively seeks partnerships with parties interested in either active or closing bases - individual citizens, communities, government agencies (local, state, tribal, and federal), regulators, environmental groups, and business enterprises.

—The major benefits of this approach are—

1. Better use of cleanup money by promoting communication and teamwork among diverse interests.
2. Reduction in the time between studying contaminated sites and cleaning them up.
3. Sustaining performance.

Demonstration of immunoassay kit at NS Treasure Island RAB meeting

The Restoration Advisory Board (RAB) is a key tool in the Navy's efforts to involve all people who have a stake in the cleanup process. It is a forum through which members of nearby communities can convey their concerns to the Navy about its cleanup programs at active, realigning, closing, and closed installations.

RAB members provide an essential channel of communication to the community and they bring ideas to the Navy about how to perform cleanup projects better. They help to increase community understanding of the Navy's cleanup goals and the complex rules and requirements under which the Navy must perform those cleanups. They review cleanup plans and documents, frequently raising questions which reflect community concerns. They participate in evaluating risk levels for contaminated sites, helping to set priorities, and making recommendations which can affect a base's work plans. And they give advice to decision-makers on many parts of the cleanup program, especially in selecting remedies to be used in the site cleanup process. This is particularly significant because it ensures that the Navy installation is fully aware of the options the community favors and it helps build trust and community confidence in Navy cleanup action.

RABs are made up of representatives from the local community (who are unpaid volunteers), from DON, from the EPA, and from local, tribal, and state government agencies. They are co-chaired by a base representative and a community member, and all members have equal rank. Each RAB is structured to meet community needs as well as the needs of the base's cleanup program.

Community participants sign in at a RAB meeting

Using Technology To Do the Job:

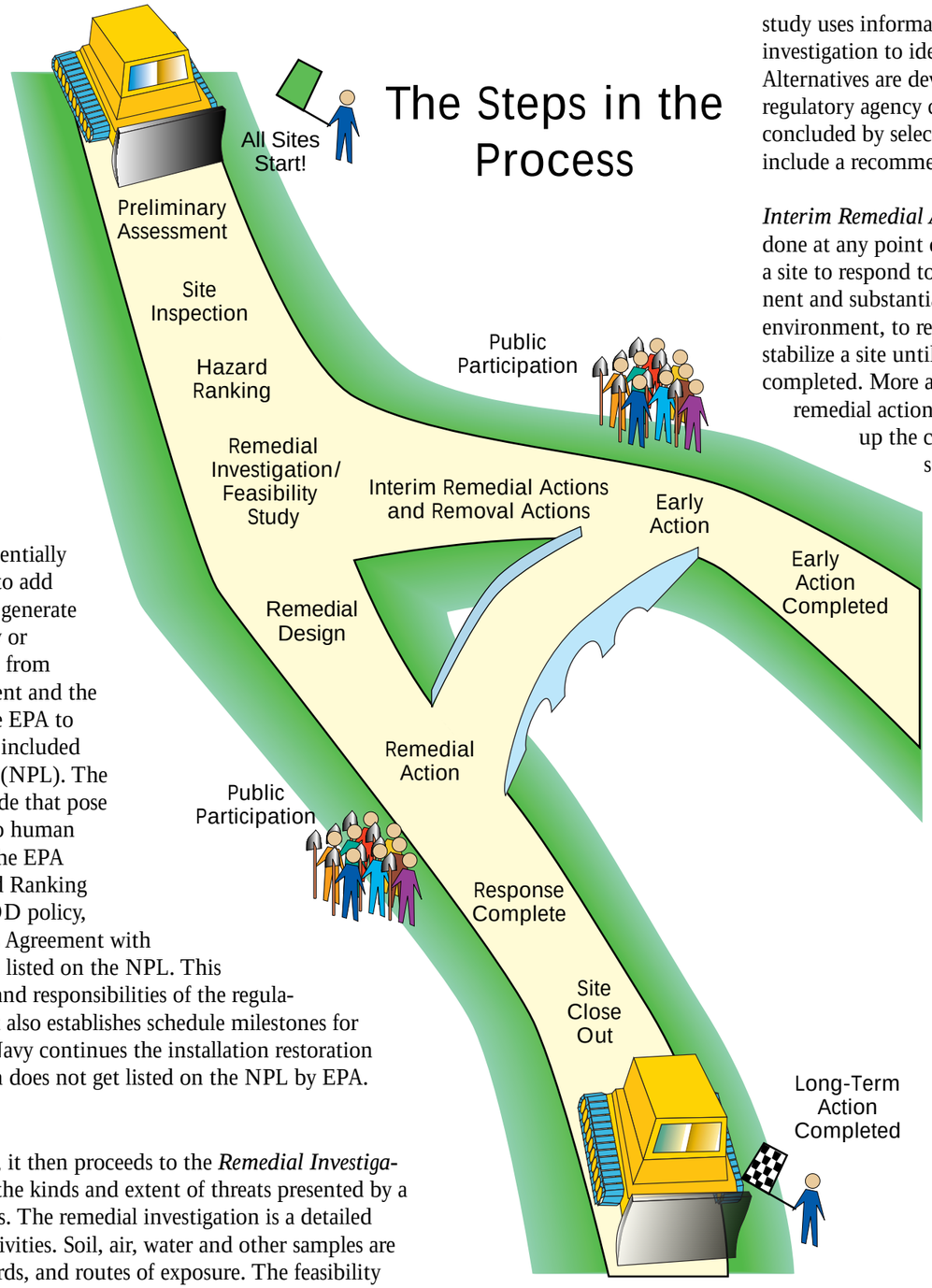
Fire fighting foam is an example of mission operations that lead to unique cleanup requirements

The Navy's environmental cleanup effort is complex and far-reaching because of the nature of the service, the kinds of operations it conducts, the location and sizes of its bases, and myriad local influences which impact the process. It must and does employ technology to help solve its cleanup challenges. Though the Navy has identified contaminants which are common to both civilian industry and to many Navy and Marine Corps bases (such as fuels and cleaning solvents), it also must deal with such things as ordnance residue and with fire fighting agents (so important to mission operations). A one-size-fits-all approach to cleanup doesn't work. That's why the Navy uses and continues working on developing innovative management approaches and cost-effective technologies for its installation restoration program. The Navy Environmental Leadership Program is an important part of the Navy's overall environmental program. The Navy designated Naval Air Station North Island, California and Naval Station Mayport, Florida as test beds for new technologies, procedures and management initiatives, including those in the cleanup arena. These bases provide two focal points for test and evaluation of new technologies and for demonstration of proven technologies for transfer throughout the service. These bases are the forward presence of our SMART Cleanup Initiative.

A large fuel storage tank with its pipeline, a typical Navy restoration program site

The following pages depict our Road Map to Restoration, the innovative technologies we've employed along the way and the successful results of some of our efforts.

Road Map to Restoration



The Steps in the Process

Step One:

The Navy's installation restoration process usually starts with a *Preliminary Assessment* conducted by the Naval Facilities Engineering Command at a Navy or Marine Corps base. Its purpose is to identify contaminated sites. Existing information on past hazardous waste disposal operations or hazardous material spills is collected and reviewed to determine the potential for the presence of hazardous substances, the potential threat and whether removal or treatment may be necessary.

Step Two:

If a site is identified in the preliminary assessment as potentially contaminated, a *Site Inspection* is done. The purpose is to add to the information already collected and, if necessary, to generate sampling and other field data to find out if further study or action is needed. Information from both the preliminary assessment and the site inspection are used by the EPA to determine if a base should be included on its National Priorities List (NPL). The NPL is a list of sites nationwide that pose the greatest potential threat to human health or the environment. The EPA classifies sites using its Hazard Ranking System. The Navy, under DOD policy, enters into a Federal Facilities Agreement with the EPA shortly after a base is listed on the NPL. This agreement specifies the roles and responsibilities of the regulatory agencies and the Navy. It also establishes schedule milestones for future cleanup actions. The Navy continues the installation restoration process even if the installation does not get listed on the NPL by EPA.

Surface water sampling

Step Three:

If a site is verified as contaminated in the site inspection, it then proceeds to the *Remedial Investigation/Feasibility Study* step. The purpose is to figure out the kinds and extent of threats presented by a release, and if appropriate, to evaluate proposed remedies. The remedial investigation is a detailed study that involves a variety of sampling and analysis activities. Soil, air, water and other samples are collected to determine contaminant characteristics, hazards, and routes of exposure. The feasibility study uses information generated from the remedial investigation to identify potential cleanup actions. Alternatives are developed and evaluated and public and regulatory agency comments are considered. This step is concluded by selection of a remedy, which may also include a recommendation of no further action.

Soil sampling

Interim Remedial Actions and *Removal Actions* can be done at any point during the investigation or cleanup of a site to respond to a release that may present an imminent and substantial threat to human health or the environment, to reduce the overall risk of a site, or to stabilize a site until the final cleanup action can be completed. More and more, the Navy uses interim remedial actions as a tool to quickly respond to site contamination, reduce study costs, and speed up the cleanup process. If a site is identified in the remedial investigation/feasibility study step as requiring a cleanup action, it then moves into the *Remedial Design* step. All technical drawings and specifications needed to implement the chosen cleanup action are prepared. The remedial design begins the cleanup step.

Step Four:

Remedial Action is the actual construction, operation and implementation of the selected final cleanup action. The Navy's overall goal is to spend at least 60% of its Environmental Restoration, Navy funds on cleanups each year.

Step Five:

When the Navy has completed all necessary study and cleanup, and considers all work to be finished, a site is designated as *Response Complete*. At this point the Navy seeks concurrence from the appropriate regulatory agencies that all work is done. When no further actions are considered by the Navy to be appropriate because a site doesn't pose a threat to human health or the environment, and regulator consent has been given, the site is designated *Site Close Out*. At National Priorities List bases, the EPA must concur with this decision. A site may be closed out at the end of the preliminary assessment phase, the site inspection phase, the remedial investigation/feasibility study phase, or the remedial action phase.

Restoring sites to their natural condition is the goal of the Navy's IR program.

Innovative Treatment Technologies

What are Innovative Treatment Technologies?

Treatment technologies are chemical, biological, or physical processes applied to hazardous waste or contaminated materials to permanently change their condition. They destroy contaminants or change them so that they are no longer hazardous or at least are less hazardous. Innovative treatment technologies are newly developed processes that have been tested and used as treatments for hazardous waste or other contaminated materials, but still lack enough information about their cost and how well they work to predict their performance under a variety of operating conditions.

Bioremediation

Bioremediation is a treatment process that uses naturally occurring microorganisms (e.g., yeast, fungi, bacteria) to break down hazardous substances into less toxic or nontoxic substances. Microorganisms, just like humans, eat and digest organic substances for nutrients and energy. In chemical terms, organic compounds are those that contain carbon and hydrogen atoms. Certain microorganisms can digest organic compounds such as fuels and solvents that are hazardous to humans. The microorganisms break down the organic contaminants into harmless products. Once the contaminants are "eaten", the microorganism population dies off because they have used all of their food.

Bioremediation cell construction at MCAS Yuma, Arizona

Chemical Dehalogenation

Halogens are a family of chemicals that include chlorine, fluorine, and iodine. Halogenated compounds (those materials that have chlorine, fluorine, or iodine in their structure) are often particularly hazardous to humans and the environment because they are stable. These chemicals don't break apart very easily. Examples of halogenated compounds are solvents such as dry cleaning fluid, and some paint strippers, PCBs and dioxins. Chemical dehalogenation is a process used to treat halogenated organic contaminants. By breaking the halogens (chlorine is the most common) off a contaminant, chemical dehalogenation converts toxic materials to less toxic or nontoxic materials. Chemical dehalogenation is a promising technology because the treatment time is short, energy requirements are moderate, and operation and maintenance costs are relatively low. In addition, the technology can be brought to the site, so hazardous wastes do not have to be transported.

Chemical dehalogenation processing equipment on Naval Station Guam

Phytoremediation

Constructed Wetlands at Naval Amphibious Base, Little Creek, Virginia

Phytoremediation is the use of plants and trees to clean up contaminated soil and water. Plants on a contaminated site can break down organic pollutants or stabilize metal contaminants by acting as filters and traps usually at sites with low levels of contamination near the surface. Trees can act as organic pumps when their roots reach down toward the water table and establish a dense root mass that takes up large quantities of water. The pulling action caused by the roots decreases the tendency of surface pollutants to move downward toward ground water and into drinking water. Phytoremediation can be used to clean up metals, pesticides, solvents, explosives, crude oil, and fluids seeping from landfills. Phytoremediation is used in combination with other cleanup approaches as a finishing step. Although phytoremediation is significantly slower than mechanical methods, and is limited to the depth that the roots can reach, it can clean out the last remains of contaminants trapped in the soil that mechanical treatment techniques sometimes leave behind.

In Situ Soil Flushing

In situ, meaning in place, soil flushing is a technology that floods contaminated soils with a solution that washes the contaminants to an area where they are removed. The flushing solution is typically one of two types of fluids: (1) water only or (2) water plus additives such as acids, bases, or surfactants (like a soap). The process begins with the drilling of injection wells and extraction wells into the ground where the contamination has been found. The soil flushing equipment then pumps the flushing solution into the injection wells. The solution passes through the soil, picking up contaminants along its way as it moves toward the extraction wells. The extraction wells collect the dirty flushing solution and pump it to the surface. Here the mixture is treated by a wastewater treatment system to remove the contaminants. The contaminants are treated or disposed of properly, and the cleaned water is returned to the flushing system to be used again and again. In situ soil flushing works best at sites with soil that has spaces that permit the wash solution to move through it (i.e., low silt and clay concentrations).

Demonstration of a soil flushing technology which uses a surfactant to help remove contamination

Natural Attenuation

Natural attenuation makes use of already occurring processes in nature to keep contamination from spreading and to lower the concentration of pollutants at contaminated sites. Natural attenuation processes may include biodegradation, chemical transformation, dilution, dispersion, or binding contaminants to soil particles so the contamination does not spread. In certain situations, natural attenuation is an effective, inexpensive cleanup option and the most appropriate way to remediate some contamination problems. Natural attenuation is sometimes mislabeled as a "no action" approach since it simply uses what's already there. Natural attenuation focuses on confirming and monitoring of existing remediation processes rather than relying totally on man-made or engineered technologies. Low levels of hydrocarbon contamination (such as fuel spills) are good candidates for natural attenuation.

Monitoring wells such as this one are installed to track progress on sites relying on natural attenuation processes for remediation

Solvent Extraction

Solvent extraction performed at NAS North Island

Solvent extraction is a treatment technology that uses a fluid that can dissolve another substance (the solvent), to separate or remove (extract) organic contaminants from sludges, sediments, or soil. Solvent extraction does not destroy contaminants; it concentrates them so they can more easily be recycled or destroyed by another technology. The entire process is conducted on site and begins by excavating the contaminated material and moving it to a staging area where it is prepared for treatment. The material is mixed with the solvent in an extractor where the contaminants move into the solvent. The contaminated solvent layer is then separated and disposed of appropriately.

Soil Vapor Extraction/Air Sparging

Some organic contaminants in soil will readily separate from the soil particles if a stream of air is passed over them. These contaminants are referred to as volatile or semi-volatile (able to evaporate). Soil vapor extraction is a process that physically separates these contaminants from soils above the water table. By pulling a vacuum through a system of underground wells, contaminants are sucked to the surface as vapor or gas. In addition, air injection wells are often installed to increase air flow and improve the removal rate of the contaminant. An added benefit of introducing air

Soil vapor extraction equipment for future use at MCAS El Toro

into the soil is that it can stimulate bioremediation of other remaining contaminants. At sites where contamination is located in the water-soaked soil that lies below the water table, air sparging is used. Air sparging is the process of pumping air into the soaked soil to help flush (bubble) the contaminants up into the drier zone where the soil vapor extraction wells can remove them. Neither technique requires excavation of the contaminated soil, which significantly reduces cost. The technologies are relatively simple to install, can be used effectively with other treatment technologies, and work well under a variety of site conditions.

Thermal Desorption

Thermal desorption is a process that involves heating soils to high temperatures (200°F - 1,000°F) so that contaminants will turn into gas (vaporize) and separate themselves from the soil. The gases are then collected and treated. Thermal desorption is effective at separating organics from refining wastes, coal tar wastes, wastes from wood treatment, and paint wastes. It can separate solvents, pesticides, PCBs, dioxins, and fuel oils from contaminated soil. This treatment requires soil excavation and is fairly energy intensive.

Demonstration of an in-situ thermal desorption process at the former Mare Island Naval Shipyard

Treatment Walls

Treatment walls are structures installed underground to treat contaminated ground water found at hazardous waste sites. Also called passive treatment walls or permeable barriers, treatment walls are put in place by constructing a giant trench across the flow path of contaminated ground water and filling it with one of a variety of materials specific to the type of contaminant. As the contaminated ground water passes through the treatment wall, the contaminants are either trapped by the treatment wall or transformed into harmless substances that flow out of the wall. The major advantage of treatment walls over traditional treatment methods such as pump-and-treat is that they are passive systems that treat the contaminants in place. There is no need to dig up contaminated soil or pump out contaminated water, there are no parts to break, no need for electricity, and, since there is no equipment on the surface, property can be put to productive use while it is being cleaned up. The EPA estimates at least a 50 percent cost savings by using treatment walls instead of pumping out contaminated ground water.

Installation of a treatment wall system at the former NAS Moffett Field